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THE EXTERNAL MORPHOLOGY OF THE IMMATURE STAGES OF THE BEE FLY, *SYSTOECHUS VULGARIS* LOEW, (DIPTERA, BOMBYLIIDAE), A PREDATOR OF GRASSHOPPER EGG PODS

BY V. L. BERG,

Dominion Entomological Laboratory, Saskatoon, Sask.

INTRODUCTION

During the grasshopper egg surveys conducted in Saskatchewan by the Dominion Entomological Laboratory at Saskatoon since 1932, bee fly larvae were commonly found destroying grasshopper egg pods. In the early years of these annual surveys little was known regarding the species, life-history or economic importance of these larvae. This prompted a study of the bionomics of the species, subsequently determined as *Systoechus vulgaris* Loew, and a morphological study of its immature stages.

This paper includes the morphological study of the three larval instars and of the pupa. Since the original description of the fly is not generally available it is also included here. An additional publication on the bionomics of the species is planned for the future.

This morphological study was personally supervised by Dr. L. G. Saunders, Professor of Zoology and Entomology, University of Saskatchewan, without whose aid and advice the work would not have been possible. The material for the study was collected by the author and other officers of the Dominion Entomological Laboratory at Saskatoon while engaged in grasshopper surveys.

EGG

Eggs were not obtained free in the soil but were dissected out of gravid females. A number of the largest of the eggs obtained in this manner averaged 0.87 mm. by 0.19 mm., the largest and most perfect being 0.88 mm. by 0.23 mm. These eggs were white, bluntly elliptical and with no external markings.

FIRST INSTAR LARVA

1.5–1.7 mm. long, slender, elongate, cylindrical, with small head, three thoracic and nine abdominal segments (Fig. 1A); body widest at middle and tapering slightly both ways; metapneustic; color white, body wall transparent. Thoracic segments each with one pair of long curved hairs on ventro-lateral surface; body normally curved anteriorly (Fig. 1B), with raised thorax, head and first thoracic segment directed downward. Two widely separated pseudopods (*abp*) near anterior margins of abdominal segments 2-6, none on 7, and two double pseudopods near posterior margin of 8. One pair of raised spiracles on dorso-lateral surfaces of 8 at posterior margin. Ultimate abdominal segment small, tapering abruptly upward to apex, bearing one pair of long curved anal hairs.

Head (Fig. 1C) prognathous, roughly conical, with relatively large membranous capsule terminating anteriorly in parietals; anterior to parietals rather elongate mouth-parts.

Parietals (*pa*) continuous across upper surface of head, covering greater portion of labrum, membranous, margins bounded below by sclerotized band (dotted lines in figure); incompletely separated from rest of head capsule on lower surface of head; bearing antennae on dorso-lateral surfaces. A row of three hairs medial to antenna on upper surface of head, posterior hair very long, nearly four times length of anterior hair, central hair very short; three hairs,

two long and one very short on under surface of head just below outer margin of antenna.

Antenna (*an*) consisting of large membranous area heavily sclerotized at margins, probably to be regarded as single very short, wide segment.

Mouth-parts (Fig. 1C). Only labrum, maxillae and mouth-hooks visible externally.

Labrum. External portion small, sclerotized, triangular (*lr*), projecting forward beyond anterior margin of parietals, continuing posteriorly below parietals to fuse with dorsal plate (*dp*) of pharyngeal skeleton.

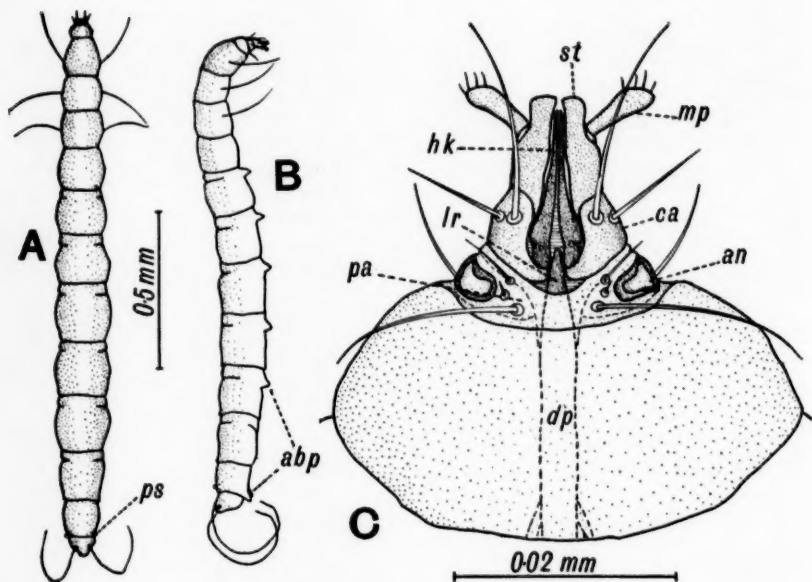


Fig. 1. *Systoechus vulgaris* Loew, first instar larva; A, dorsal, B, lateral view; C, head, dorsal view; *abp*, abdominal pseudopod; *an*, antenna; *ca*, cardo; *dp*, dorsal plate; *hk*, mouth-hook; *lr*, labrum; *mp*, maxillary palp; *pa*, parietals; *ps*, posterior spiracle; *st*, stipes.

Maxilla two-segmented, consisting of basal cardo (*ca*) and distal stipes (*st*); cardo roughly rectangular but with posterior inner angle produced medially to articulate with mouth-hook, bearing one pair of long hairs, outer about equal in length to stipes, inner nearly twice that length, extending well beyond apex of stipes; stipes roughly elongate-rectangular but cut away on antero-lateral margin where maxillary palp articulates; central hair on ventral surface. Maxillary palp consisting of single, elongate, clavate segment bearing four long setae on anterior distal face.

Mouth-hook (*hk*) very similar to that of third instar (Fig. 7C), but with imbrications on sides not evident; articulation with cardo at upper posterior angle of mouth-hook.

SECOND INSTAR LARVA

4 mm. long, 0.8 mm. wide when fully grown; composed of a small head, three thoracic and nine distinct abdominal segments with intersegments on 2-6; body gently curved throughout, cylindrical, but with slight lateral ridges on abdominal segments; thorax with pair of short hairs on ventro-lateral surfaces of each segment; abdomen devoid of hairs or pseudopods. Larva amphipneustic, with prothoracic and penultimate abdominal segments bearing spiracles similar

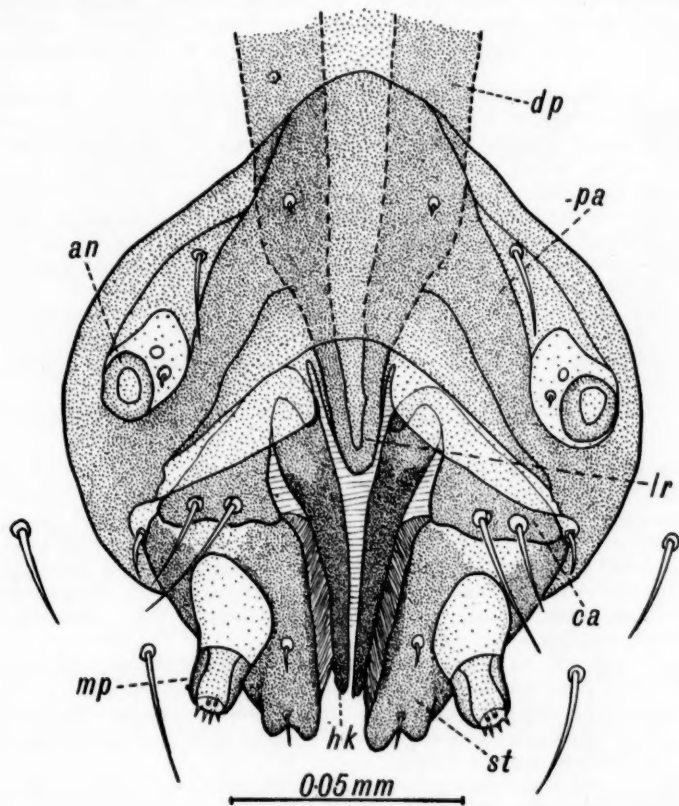


Fig. 2. *Systoechus vulgaris* Loew, second instar larva; head, face view, extent of membranous portion not shown; *an*, antenna; *ca*, cardo; *dp*, dorsal plate; *hk*, mouth-hook; *lr*, labrum; *mp*, maxillary palp; *pa*, parietals; *st*, stipes.

in structure to those of third instar (Fig. 3B, C.) but with only 6-7 sclerotized loops around margin.

Head of fully grown larva (Fig. 2) consisting of short membranous capsule (extent not shown in figure) and anterior sclerotized parietals strongly depressed. Parietals and mouth-parts flattened on anterior surface; two pairs of hairs on lower lateral surfaces of membranous portion of head capsule, lateral to stipes.

Parietals (*pa*) (Fig. 2) continuous across upper portion of labrum; extent and relative degrees of sclerotization difficult to describe but readily seen

in Fig. 2; area bearing antenna slightly concave, with one moderately long hair; pair of very short, stout hairs on portion of parietals over labrum; short stout hair on small, rather membranous area at upper outer angle of stipes; on either side of exposed portion of labrum, membranous area overhanging cardo and upper portion of mouth-hook.

Antenna (an) consisting of single, short, ring-like segment borne on a broad, flat membrane also bearing two small papillae, lower having short seta at apex; apex of antenna membranous.

Labrum (lr). Exposed portion of labrum roughly triangular, continuing upwardly behind parietals; in lateral view labrum observed to fuse with under surface of dorsal plate of pharyngeal skeleton as in third instar (Fig. 5 A, D).

Maxilla two-segmented, as in first instar, but cardo (*ca*) comparatively much smaller, triangular, flattened and articulating with upper outer angle of mouth-hook, lower margin fusing with stipes; pair of long hairs near lower margin of cardo; stipes (*st*) three-sided, hollow, anterior surface triangular, apex broadly notched, maxillary palp occupying most of central portion; short hair medial to each palp; in notched apex of stipes another short hair; long hair on posterior surface near outer margin; maxillary palp borne on large membrane, one-segmented, apex with four short setae and pair of minute pores with duct visible below.

Labium a tiny structure concealed between bases of maxillae, consisting of sclerotized ring with membranous apex bearing several short setae.

Mouth-hooks very similar to those of third instar larva (Fig. 5C) but blade-like portion relatively longer, reaching apex of stipes.

Pharyngeal skeleton similar to that of third instar larva (Fig. 5D, E).

THIRD INSTAR LARVA

Average length when fully grown and extended 10 mm., but usually curved, often with head and ultimate abdominal segment approximating; immediately after second moult length, when extended, about 5 mm. Head small, dark brown; body yellowish, smooth, amphipneustic; thorax with pair of weak hairs on ventro-lateral surfaces of each segment; abdomen devoid of pseudopods or hairs, flattened ventrally, tapering posteriorly, ultimate and penultimate segments small; segments distinct, intersegments obvious on 2-5, dorso-lateral surfaces distinctly swollen.

Head (Fig. 4A, B) small, consisting of anterior sclerotized parietals and mouth-parts and posterior membranous portion more extensive ventrally than dorsally and bearing two pairs of hairs on lower lateral surfaces. Hypognathous. Mouth-parts and parietals flattened anteriorly, making an angle of approximately 90 degrees with dorsal surface of head.

Parietals (pa) pair of large plates (Fig. 4A, B) lateral to labrum; anterior surface roughly triangular, narrow above, slightly concave, lower portion curving posteriorly, bearing downwardly directed antenna; sides rounded, bearing hairs as in Fig. 4B.

Antenna (an, Fig. 4A, D) small, two-segmented, directed downward; basal segment comparatively large, rounded, sides and less than basal half heavily sclerotized, distal half less heavily sclerotized; basal segment connected by membrane to small distal segment consisting of short stalk and small knob-like head; membrane bearing two small sensory papillae on outer side, most lateral having small seta at apex; within antenna two antennal glands, connected by short ducts to apical segment, no external pores visible.

Mouth-parts consisting of labrum with epipharynx, pair of maxillae, labium, hypopharynx and mouth-hooks.

Labrum (lr) a large bulging structure (Fig. 4A, B) projecting anterior to rest of head; anterior surface broad, somewhat concave, widest above, tapering

PLATE XI.

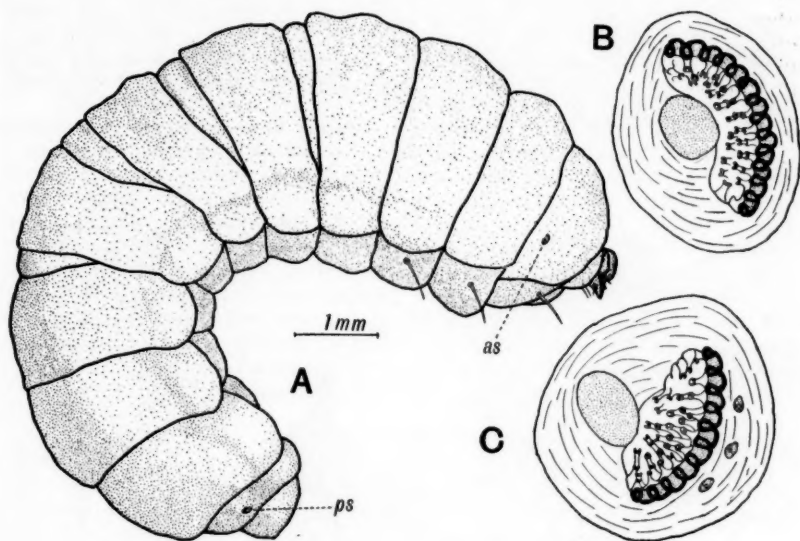


Fig. 3. *Systoechus vulgaris* Loew, third instar larva; A, lateral view of larva; B, anterior, C, posterior spiracle; as, anterior spiracle; ps, posterior spiracle.

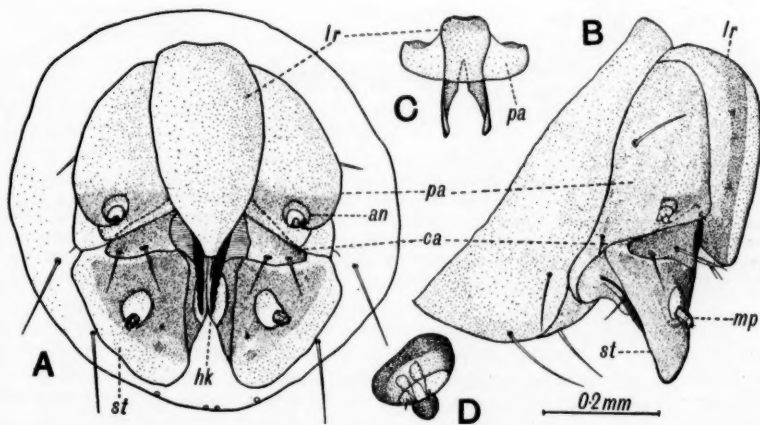


Fig. 4. *Systoechus vulgaris* Loew, third instar larva; A, anterior, B, lateral view of head; C, labrum and parietals, dorsal view (less highly magnified than A and B); D, antenna, dorso-lateral view; an, antenna; ca, cardo; hk, mouth-hook; lr, labrum; mp, maxillary palp; pa, parietals; st, stipes.

toward lower extremity projecting between and beyond mouth-hooks; sides meeting on ventral surface only in anterior region (Fig. 5D) forming acute angle; from this point ventral margins diverging posteriorly, sloping upward; dorsal surface (Fig. 4C) rounded, tapering posteriorly to entrance to head capsule; within head capsule sides not united, dorsal margins passing below and fusing with dorsal plate of pharyngeal skeleton (Fig. 5A, D, E); near ventral margin and slightly behind apex pair of hairs each with large basal papilla, base of hair enclosed by epipharynx (Fig. 5A, B).

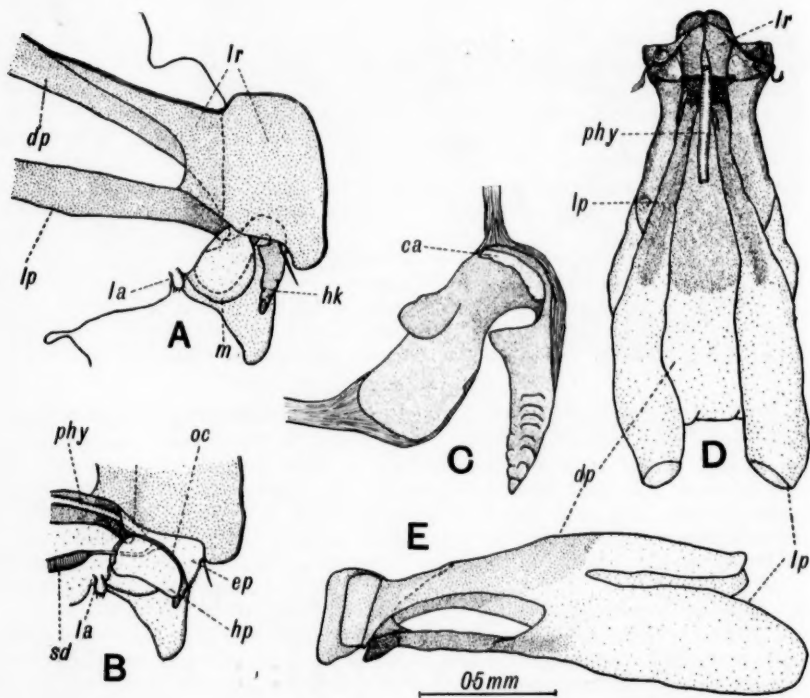


Fig. 5. *Systoechus vulgaris* Loew, third instar larva; A, head, median sagittal section, epipharynx and hypopharynx removed; B, same, epipharynx and hypopharynx not removed; C, right mouth-hook, lateral view; D, ventral view of head and pharyngeal skeleton, maxillae and mouth-hooks removed; E, same, lateral view; *ca*, cardo; *dp*, dorsal plate; *ep*, epipharynx; *hk*, mouth-hook; *lp*, hypopharynx; *la*, labium; *lr*, labrum; *m*, membrane; *oc*, oral cavity; *phy*, pharynx; *sd*, salivary duct.

Maxilla (Fig. 4A, B) two-segmented, cardo (*ca*) still more reduced proportionally than in second instar, triangular, partially concealed by parietals, upper portion articulating with upper outer angle of mouth-hook (Fig. 5C); usual pair of hairs near lower margin of cardo; stipes large, hollow, three-sided; anterior surface triangular, margins less heavily sclerotized than central portion; very short seta medially to and slightly below maxillary palp; medial side of stipes sclerotized, bearing membrane (*m*) enclosing basal portion of mouth-hook (Fig. 5A); hind surface of stipes rather membranous, bearing hair near outer margin, fusing at base with membranous head capsule. Maxillary palp a single,

short, cylindrical segment arising from lower side of rounded membrane in centre of anterior face of stipes; membranous apex bearing four short setae.

Labium (*la*, Fig. 5A, B) small, cylindrical, only slightly sclerotized, on median line between bases of maxillae; exposed apex bearing three short setae.

Epipharynx (*ep*, Fig. 5B) median double-walled, membranous structure attached to lower lateral surfaces of labrum, receiving pharynx in its hinder portion; lower surface invaginated, anterior margin serrated.

Hypopharynx (*hp*, Fig. 5B) triangular, double-walled, membranous, ventral to epipharynx, hind margins reflexed and continuous with membranes of medial sides of stipes; dorsal surface invaginated, receiving opening of salivary duct anterior to opening of pharynx; epipharynx and hypopharynx in contact forming closed oral cavity (*oc*), or distipharynx (Peterson, 1916), opening anteriorly between mouth-hooks.

Mouth-hook (*hk*, Figs. 4A, 5A; Fig. 5C) roughly divisible into two parts, anterior vertical blade-like portion and larger basal portion at acute angle to it; blade-like portion somewhat curved, medial side concave, outer side convex; in anterior half, sides and hind margin imbricated; (serrated appearance in anterior view (Fig. 4A) only on outer side because of concavity of medial side); basal portion broad, flattened, but with large lateral expansion at posterior margin for loose articulation with anterior end of lateral plate (*lp*) of pharyngeal skeleton (Fig. 5A).

Pharyngeal skeleton composed of dorsal plate and pair of elongate lateral plates.

Dorsal plate (*dp*, Figs. 5A, D, E.) broad, widest at middle, rounded, fusing anteriorly with parietals and labrum, extending posteriorly into mesothorax; distal third white, non-pigmented, remainder sclerotized, brown.

Lateral plate (*lp*, Fig. 5A, D, E) consisting of anterior, heavily sclerotized rod-like portion expanding posteriorly into large, thick, non-pigmented portion; upper margin in extreme anterior region fused solidly with ventral margin of labrum; this portion of lateral plate boot-shaped, anterior margin forming loose articulation with mouth-hook; pharynx passing medially and opening in epipharynx just beyond anterior extremity; lateral plate fused with lateral margin of dorsal plate near middle by broad non-pigmented band; hind margin reaching distal margin of mesothorax.

SPIRACLES

Prothoracic spiracles (*as*, Fig. 3A; 3B) composed of outer sclerotized band, several rows of short, horizontal tubes, and central, circular, sclerotized structure, whole surrounded by circle of membrane; sclerotized band consisting of varying number of loops, usually 9-14 with average 12, occasionally only 7-8, number often varying by one in members of pair.

Posterior spiracles (*ps*, Fig. 3A, C) similar to prothoracic spiracles but sclerotized band with fewer loops (8-11) and three small sclerotized rings in membrane behind.

PUPA

Length 8-9 mm., yellowish at first, head and thorax later becoming dark brown (Fig. 6A); head with eight stout, thorn-like cephalic processes, black-brown, their form and disposition best seen in Fig. 6C; (spine-like continuations of lateral cephalic processes easily broken, and often not present); in addition, four pairs of long slender hairs and, on postero-dorsal surface near median line, pair of large tubercles. Thorax with three hairs on each side above base of wing sheath; wing sheath with slight tubercle about one-third from base and near costal margin; prothoracic spiracle (*prs*) prominent, directed backward; wing sheath extending to about middle of third abdominal segment, forelegs (*ft*) beyond apex of wing sheath as far as base of tarsal claws, midlegs as far as apex of third tarsal joint, hind legs (*ht*) as far as apex of second tarsal joint,

tip of tarsus reaching to posterior margin of fifth abdominal segment. Abdomen with transverse row of recumbent brown spines (Fig. 6A, B) on dorsal surface of each segment; segment I with 12-14 of these spines, reflexed at apices only; on 2-5, more numerous and reflexed at both apices and bases with exception of one or two at extreme lateral; on 6, reflexed usually only at apices; on 7, spines with much shorter recumbent portion, reflexed only at apices; interspersed with

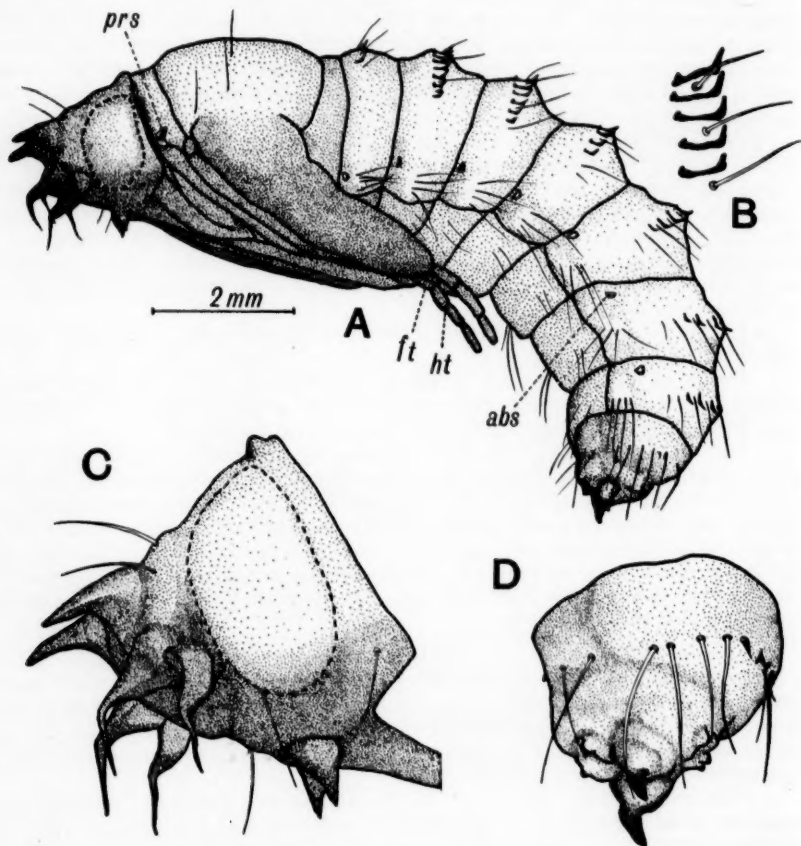


Fig. 6. *Systoechus vulgaris* Loew, pupa (male); A, pupa, lateral view; B, dorsal abdominal spines, segment 3; C, head, lateral view; D, ultimate abdominal segment, postero-lateral view; abs, abdominal spiracle; ht, hind tarsus; ft, fore tarsus; prs, prothoracic spiracle.

spines transverse row of moderately strong hairs, usually a hair to every two spines, occasionally alternating or with a hair to every three spines; abdominal spiracles somewhat similar to larval spiracles, directed forward; on post spiracular areas, abdominal segments 1-7, group of four long stiff bristles and on ventro-lateral surfaces two weak hairs (occasionally three or four hairs in place of usual two); ultimate abdominal segment (Fig. 6D) with transverse series of about four small spines and several long stout bristles reaching to dorso-lateral margins; on ventro-lateral surfaces two long hairs (often absent); at apex pair of large swellings each terminating in moderately stout spine; anterior to

anal spines on dorsal surface a group of small tubercles; on ventral surface pair of swellings (present only in male) each with tubercle at apex.

ADULT

The following is the original description of the fly, as published by Loew (1863) and supplied to the author by C. F. W. Muesebeck, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, Washington, D. C., and O. Peck of the Division of Systematic Entomology, Entomological Branch, Ottawa.

"*Systoechus vulgaris* nov. sp. ♂ et ♀. Nigricans, scutello praeter basim ferrugineo, flavo-pilosus, capite praeter mentum et occiput nigropiloso, pedibus flavis stulas ferrugineas gerentibus, femoribus basim versus plerumque nigris, alis hyalinis.—Long. corp. 3 1/4-3 2/3 lin., Long. al 3 1/2-3 5/6 lin.

"Nigricans, flavo-pilosus, pilis nigris in thorace, scutello et abdominis omnino nullis. Caput nigro-pilosum, occipite tamen confertim flavo-piloso et mento pilis dilutius flavis vestito; pili breviores flavi nigris in mystace immixti. Oculi maris anguste separati; frons foeminae latissima, infra maculam permagnam geminam, atram et nitidam gerens. Pedes flavi, tarsis inde ab articuli primi aut secundi apice ex fusco nigris, femoribus basim versus pleuromque nigris, setulis omnibus dilute ferrugineis vel sordide ochraceis. Alae hyalinae basi lutescente. —(Nebraska; Osten-Sacken.)"

Osten Sacken (1877), commenting on the original description, writes that, "The fulvous hairs on the face are often more abundant than Dr. Loew's wording implies; in the female they extend to the front, especially along the eyes."

SUMMARY

As stated by Imms (1930), the first instar larvae of the Bombyliidae "are elongate and slender, with a small head and twelve trunk segments. They are stated to be metapneustic; each thoracic segment bears a pair of long setae, and a further pair is carried at the anal extremity." No mention is made of abdominal pseudopods, but in all other respects the first instar larva of *S. vulgaris* is typical of the group. The thoracic and anal hairs and the abdominal pseudopods all aid in rapid motion. The head is directed forward, and its well developed maxillary palps and long sensory hairs are typically those of an active larva.

The first instar larva undergoes hypermetamorphosis to produce the inactive second instar larva. The abdominal pseudopods and anal hairs disappear, the thoracic hairs are reduced, thoracic spiracles develop and the body becomes less slender. Accompanying the general changes in the body, there is a considerable modification of the head. In the second instar larva the parietals are sclerotized, and, together with the mouth-parts, are flattened and laterally expanded. The maxillary palps and sensory hairs are shortened and the cardo is reduced proportionally. A flexure at the posterior margin of the parietals results in a depression of the head, and a condition intermediate to the prognathous head of the first and the hypognathous head of the third instar larvae is produced.

The body of the third instar larva is swollen and crescentic. The head is completely depressed, the parietals are modified to present anterior and lateral surfaces, the antennae have two segments, in place of the single segment of the first and second instar larvae, and are directed downward, and the maxillary palps and cardo are still more reduced proportionally. Most obvious of all is the protrusion of the labrum, with the obliteration of the central portion of the parietals, to produce the large bulging structure characteristic of the last stage larvae of the Bombyliidae.

It is impossible at the present time to define any characters which distinguish the larvae of *S. vulgaris* from those of the other members of the family,

since the larvae of only a very few species have been described. The larval instars of *S. vulgaris* can readily be distinguished from one another, with only a hand lens, by the elongate body and anal hairs of the first instar larva, the very slightly curved body with no anal hairs, and the flattened head with inconspicuous labrum of the second instar larva, and by the crescentic body with the more obvious head and the bulging labrum of the third instar larva.

ASTER AND GOLDENROD SEED-FEEDING SPECIES OF *COLEOPHORA* (LEPIDOPTERA).

BY ANNETTE F. BRAUN,
Cincinnati, Ohio

Five species of *Coleophora* feeding on seeds of *Aster* and *Solidago* in Ohio and Kentucky are here distinguished. All may be easily differentiated by definite characters of the male genitalia, and less easily by the female genitalia; differentiating characters of wing and antennal markings, although present, do not afford sure separation. The wings are brownish or grayish ochreous, with longitudinal white lines following veins, fold and dorsal margin, often confluent in the costal area, and more or less dusted with fuscous scales. Antennae may or may not be annulate, but the character is constant for the species.

In male genitalia the five species agree in that the two strengthening chitinized rods or ribbons of aedeagus are of equal length; they differ in the presence or absence of and the position of thorns on these rods; differences in the apical prominences of sacculus are to be noted, but are not quite constant within the species. In the female, specific characters of the genitalia are found in the form of the lower margin of the ostium; in the sinuation and lobes of the posterior margin of the genital plate on either side of the ostium; in the chitinized lateral thickenings of the walls of the ductus bursae immediately before ostium. The signa consist of a bluntly-spined convex patch and a strongly curved hook; the size of the convex spined patch may be a distinguishing specific difference (*dextrella*, Fig. 3). Some characters of the ductus bursae are of specific value, such as the width of the chitinized strip along the spined area (*subapicis*, Fig. 5); but the actual length of the spined area may vary within the species (e. g. *duplicis*). In the figures, the spined area is not all shown except in Figures 4 and 5.

Three new names are proposed. In all cases the type material includes only reared material; specimens collected on the wing at the same time and place are often not conspecific, and must be examined individually to determine the species.

The life history is essentially the same for all five species. The moths emerge at the time of blooming of the food plant, and the eggs are deposited in the flowers. The larvae at first feed within the seeds. The case spun just after leaving a seed merely converges at the apex, later becoming definitely three-valved. It is more or less decorated with parts of the inflorescence, especially pappus, which is fastened in a ring behind the mouth. From the attached case the larva mines into the ripening seeds and sometimes into the receptacle. Feeding is completed in late autumn or early winter. The interval from then until a week or two before emergence of the imago the next season is passed in the larval state without further feeding.

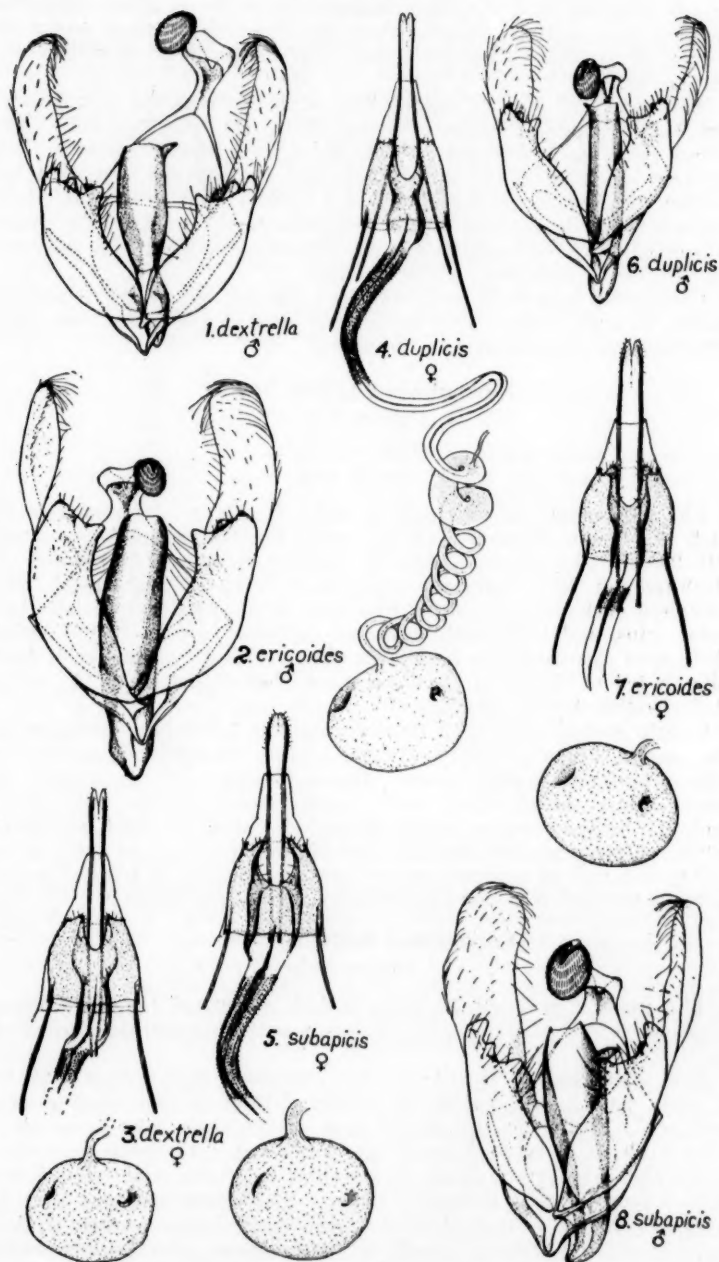
Coleophora ericoides Braun

Figures 2, 7.

Coleophora ericoides Braun, Ent. News, XXX, 128, 1919.

This species is in general distinguished by the pale grayish ochreous ground color of the wings, with white lines following the course of the veins, fold and dorsal margin, usually with complete absence of dark dusting; the antennae

PLATE XII



SPECIES OF COLEOPHORA

are annulate beneath. Some of the specimens of the series from Balsam, N. C., erroneously referred to *C. duplicis* Braun (under the original description of that species) show scattered dusting along the darker interspaces, and a whitish costal area, by confluence of white lines, but on genitalic characters of both sexes belong here.

Male genitalia (Fig. 2) figured from a specimen of the reared series (B. 590) on *Aster ericoides*, Clermont County, Ohio. The distinguishing character is the two equal and unarmed rods of aedeagus. Female genitalia (Fig. 7) figured from specimen of the same reared series. Posterior margin of genital plate rather deeply sinuate, the inner lobes broader, much exceeding the outer small narrow lobes; ductus near ostium with sides nearly symmetrically chitinated; convex spined patch in bursa copulatrix exceeding in length the curved hook and the chitinated plate from which it arises.

This species appears, at least in Ohio, to be confined to *Aster ericoides*, and is common in open fields. The larvae feed later in the season than those of the other four species—almost into the winter.

***Coleophora duplicis* Braun**

Figures 4, 6.

Coleophora duplicis Braun, Ent. News, XXXII, 16, 1921.

Haplotilia duplicis McD., Can. Ent., LXVIII, 54, 1936.

The name must be restricted to series B. 994, reared on *Aster shortii*, to which the female holotype belongs; series B. 995 on *Solidago caesia*; and series B. 996, two specimens reared on *Solidago latifolia*. As pointed out by Dr. McDunnough, these specimens show more or less whitish costal suffusion, with scattered dark scales, gathered into short lines apically, especially between the costal veins, and indistinctly annulate antennae. Series B. 993, originally included under this species, is now made the type series of the species described immediately below. None of the flown material from Balsam, N. C., originally included, is referable to *C. duplicis*.

Female genitalia (Fig. 4) figured from the holotype. Posterior margin of the genital plate slightly sinuate; lower margin of ostium nearly half the length of genital plate; ductus bursae with hour-glass shaped expansion before ostium, and with walls asymmetrically chitinated, the right side the heavier; convex spined signum exceeding the hook and its chitinated plate. Male genitalia (Fig. 6) figured from paratype of same series (B. 994). The two rods of aedeagus are of equal length, but the left rod, as pointed out by McDunnough, is armed apically with a triangular thorn.

***Coleophora dextrella* n. sp.**

Figures 1, 3.

This name is proposed for series B. 993, reared on *Aster cordifolius*, and erroneously included under *C. duplicis* Braun in the original description of that species.

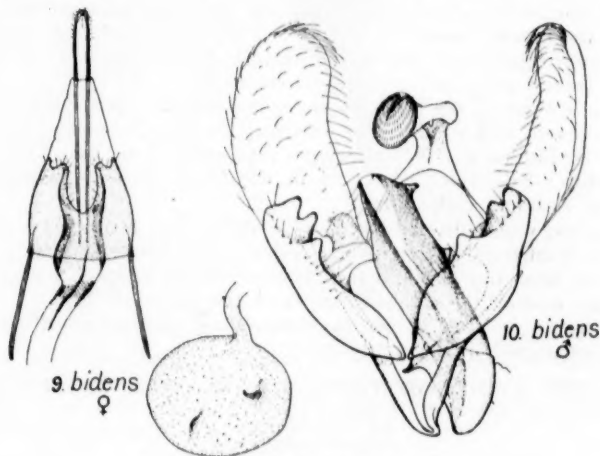
It is distinguished by the annulate antennae, annulations dark fuscous in the male, pale in the female; the scattered lines of dark dusting with less tendency to be limited to the apical area. The white lines along the veins show less tendency to be confluent in the costal area. The male genitalia (Fig. 1) furnish the only certain means of identification; the right hand rod of aedeagus is armed with a triangular thorn. The female genitalia (Fig. 3) are less sharply distinguished from those of *C. duplicis*; differences consist in the more nearly symmetrically chitinated walls of ductus bursae near ostium, with more abrupt expansion just before ostium; the convex spined patch in bursa copulatrix is small, greatly exceeded by the hook and its chitinated plate.

***Coleophora subapleis* n. sp.**

Figures 5, 8.

Antennae whitish, first segment somewhat thickened with brownish anteriorly projecting scales; beneath with distinct fuscous annulations. Forewings grayish fuscous, marked with white lines along the veins, fold and dorsal margin, between which the ground color is sparsely dusted with dark scales, darker between the branches of radius; the costal area between the upper margin of cell and costa for one-half the wing length usually white by confluence of lines. Hind wings much darker than the fore wings, gray, with but slight brownish tinge. Legs whitish, posterior pair with a fuscous line. Expanse: 14 mm.

Male genitalia (Fig. 8) figured from type. Right hand rod or ribbon of aedeagus armed with a stout thorn *before* apex, beyond which the rod ends acutely. Female genitalia (Fig. 5), figured from a paratype, very distinctly different from the other four species here discussed. Genital plate lobed, lobes elongate, inner lobes exceeding the outer lobes and convergent; lower margin of



Genitalia of *C. bidens* n. sp.

ostium broadly rounded; ductus bursae evenly expanded from spined area to ostium, with heavy slightly asymmetric chitinized walls flaring to encircle ostium; chitinized strip on lower side of ductus broadly ribbon-like through the spined area; spined patch in bursa elongate.

Type, ♂, reared on seeds of *Aster infirmus*; *paratypes*, 3 ♀, of the same rearing (B. 1603); Tackett Mountain, Rowan County, Kentucky; date of emergence of the type, August 26, 1938; paratypes August 26 to 31. Types in author's collection.

The larvae were collected October 17, 1937, at which time the mature cases had been constructed and the larvae were nearly full fed. The case is attached to the side of the large seed, and there is no evidence that the larva ever mines into the receptacle as is the case with the three preceding species. The immature case only is decorated with pappus. Mature case 6 to 6.5 mm. long, conspicuously three-valved at apex, stouter than in the preceding species, very dark brown, almost black, rarely reddish-brown below, the valves of the apex and the mouth margined with whitish silk, which later becomes discolored.

In addition to genitalic characters, the dark hind wings distinguish this species.

***Coleophora bldens* n. sp.**

Figures 9, 10.

Antennae white, indistinctly annulate. Fore wings brownish ochreous, with dorsal margin, a broad line along fold, and veins white; with sparse dusting which is sometimes entirely absent. The white lines in the costal half of the wing are more or less confluent; a narrow brown line may separate the white costa and white upper margin of cell in basal half, but most commonly the entire basal half of the costal area is white; finally the extent of the white suffusion may be such that the costal half of wing is white with a narrow brown line through cell and faint brownish streaks toward apex. Hind wings brownish fuscous, darker than the ground color of the fore wings. Hind legs whitish, with a brown line on outer side of tibia. Expanse: 13 to 14 mm.

Male genitalia (Fig. 10) figured from type. The chitinized supports of aedeagus are ribbon-like rather than rod-like, and each ends in a curved spine; the right hand ribbon is armed with two blunt thorns, one before apex, one near middle. Female genitalia (Fig. 9) figured from a paratype. Genital plate deeply sinuate on either side of ostium, the outer narrow lobes exceeding (in length) the broadly rounded inner lobes; ductus bursae with slight constriction in expanded part near ostium, chitinized thickenings of walls slightly asymmetric; spined patch of bursa copulatrix small.

Type, ♂, reared on seeds of *Aster umbellatus*; paratypes, 3 ♂, 9 ♀, of the same reared series (B. 1421); Brown County, Ohio; date of emergence of the type, September 8, 1932; paratypes September 3 to 20. Type and paratypes in author's collection; paratypes in the U. S. National Museum and in the Canadian National Collection.

The larvae were collected October 22, 1931. The early case is dark brown, two-valved; it is enlarged by lengthwise splitting and filling in with paler brown silk, and at the same time made definitely three-valved at apex; a ring of pappus is added at the neck of the case with scattered pieces farther back.

This species as well as the four preceding, can only with certainty be identified by characters of the genitalia.

SOME NEW AND POORLY KNOWN SPECIES OF COLEOPTERA*

BY W. J. BROWN,
Ottawa, Ontario.

***Cicindela formosa gibsoni* n. subsp.**

Length 14 to 16 mm., the size large as in *formosa manitoba* Leng. Holotype, allotype, and eight paratypes with the humeral lunule, middle band, and apical lunule completely confluent, the dark part of each elytron reduced to a triangular area extending to the apical third on the suture as figured; four paratypes similar but with feeble dark suffusions at the junction of each middle band with the humeral and apical lunules; one paratype with the middle band well separated from the lunules, the pattern in this specimen as in an average specimen of *manitoba*. Pronotum and dark parts of head and elytra purple, with cupreous reflections, the latter feeble in most of the specimens; the dark parts strongly cupreous in one paratype that otherwise resembles the holotype. Underside and legs greenish-blue or bluish-green, cupreous reflections very feeble or lacking.

Holotype—♂, Great Sand Hills, west of Swift Current, Sask., May 27, 1939 (A. R. Brooks); No. 4885 in the Canadian National Collection, Ottawa.

Allotype—♀, same data.

*Contribution from the Division of Entomology (Systematic Entomology), Department of Agriculture, Ottawa.

Paratypes—13, same data, May 27, 28, and 30, 1939.

Mr. Brooks informs me that the specimens were taken twenty-five miles east of the town of Fox Valley and that they occurred with another species of *Cicindela* which I find is typical *scutellaris* Say.† These are the only specimens of the latter that I have seen from a Canadian locality.

The subspecies *manitoba* is represented in the collection before me by seventy topotypical specimens. Most of these show elytral patterns much like that figured by Leng (1902, Trans. Am. Ent. Soc., XXVIII, pl. III). In some the pale areas are a little less extensive, and in a few they are slightly greater. In one specimen the pale areas are extended to produce a pattern similar to that of the four paratypes of *gibsoni* described above. In *manitoba* the dark dorsal areas are usually reddish-brown, sometimes more red as in typical *formosa* Say, but never as bright as in the subspecies *fletcheri* Criddle or purple as in



Fig. 1. *Cicindela formosa gibsoni* n. subsp., left elytron of holotype.

gibsoni. In *manitoba* the sides of the thorax beneath and usually the sides of the abdomen and the femora are strongly cupreous.

I take pleasure in naming this fine tiger beetle for Dr. Arthur Gibson, Dominion Entomologist.

***Crenitis maculifrons* n. sp.**

Length 2.5 mm.; width 1.4 mm. Head black, the sides of the front before the eyes broadly brownish-yellow; pronotum bicolored, the side margins broadly brownish-yellow, the disk with a blackish cloud which occupies two-thirds of the pronotal width and attains neither base nor apex, this blackish area not sharply limited; elytra brownish-yellow, the punctures black; body beneath black, subopaque; femora black, their distal extremities, the tibiae, and the tarsi brownish-yellow; palpi yellow, the apical three-fifths of each apical segment black.

Head and pronotum rather finely and closely punctate, very finely alutaceous but shining. Elytra rather finely punctate, the striae indicated by rows of punctures. Antennae 8-segmented; the palpi slender. Femora opaque

†I received recently from Mr. Brooks eight additional specimens of *gibsoni* which he collected at Pike Lake, Sask., on April 28, 1940. In three of these, the elytra are marked as in the holotype. In two, the dark areas of the elytra are a trifle larger than in the holotype, and there are dark suffusions at the junctions of the middle bands and apical lunules. In two others, the dark areas are only two-thirds as large as in the holotype. In one specimen, a triangular dark area is lacking, only the basal declivity between the humeri and a narrow sutural bead on each elytron remaining dark.

Pike Lake is a sand hill area situated about ten miles southwest of Saskatoon and approximately 140 miles northeast of the type locality.

and pubescent except at their distal extremities; the posterior tarsi equal in length to the tibiae.

Holotype—♂, Red Pass, B. C., August 7, 1932. (G. Stace Smith); No. 3530 in the Canadian National Collection, Ottawa.

Paratypes—5, same data; 2, same data, August 8, 1932.

In one of the paratypes, the median cloud of the pronotum is indistinct. In several it is imperfectly separated from the apical and basal margins of the pronotum; in none are the margins of the cloud sharply limited.

In Winter's key to the species of the genus (1926, Pan-Pac. Ent., III, 53), the present species falls with the eastern *monticola* Horn but differs from the latter and from all the other species included in the key in having the margins of the front pale in color. In *monticola* the black discal area of the pronotum is much larger and is abruptly limited. Except for these differences, *monticola* and *maculifrons* agree in color. The palpi are more slender and elongate in *maculifrons* than in *monticola*, *moratus* Horn, or *dissimilis* Horn.

Fornax orchesides Newm. and **molestus** Bonv.

Two species are confused in collections under the name *orchesides*. They differ in characters of the antennae and aedeagus and in color, one being reddish-brown and the other almost black. Newman (1838, Ent. Mag., V, 384) stated that *orchesides* occurred in Canada, the northern states, and at Trenton Falls, N. Y., but gave little in his description to aid in determining which of our species should bear that name. He did describe the color as "brunneum", and he failed to mention pronotal impressions that are strongly developed in the blackish species. Checking over Newman's descriptions, one finds that he applied the term "brunneum" to paler species such as *Synchroa punctata* Newm. and *Phymatodes aereus* Newm. It thus seems probable that the reddish-brown species is *orchesides*. It seems probable also that the single specimen on which Bonvouloir based his name *molestus* is the male of the paler species (1870, Ann. Soc. Fr. (4), X suppl., 376). Bonvouloir described the color of *molestus* as reddish-brown, and failed to note discal impressions on the pronotum. Furthermore, he stated that *orchesides* Newm. was a blackish species with pronotal impressions, which suggests that he considered it our darker species. Reference to Horn's description of *orchesides* (1886, Trans. Am. Ent. Soc., XIII, 26), and also to his collection, shows that he confused the two species under that name. Thus it seems probable that the names *orchesides* and *molestus* are synonymous and apply to the paler species; the darker species is described below as *canadensis* n. sp.

Fornax canadensis n. sp.

Female. Length 14 mm.; width 4 mm. Form as in *orchesides*. Blackish, the legs and antennae dark reddish-brown; body feebly shining, the elytra a little more strongly so; surface clothed with short, golden hairs; the hairs of the elytra darker, reddish-brown. Antenna extending beyond posterior prothoracic angle a distance equal to the length of the terminal segment; the second segment (measured from its base) scarcely longer than wide, half as long as the third segment; the latter widened apically but not strongly triangular, a little longer than the fourth; segments four to ten equal in length but becoming narrower apically, rather strongly serrate; each of these segments triangular, with its outer angle acute and its outer margin straight; the antennal pubescence inclined.

Clypeus narrowed at base as in *orchesides*; no carina between the antennal fossae. Head and pronotum with coarse, shallow, dense, and in part confluent punctures; base of pronotum with a punctiform impression on each side of the scutellum, the median line impressed in basal third, the disk with a moderately large and deep impression on each side of median line at middle. Elytra distinctly striate and finely punctate as in *orchesides*. Legs and venter as in

orchesides but with the prosternum less closely punctate, many of the punctures at its middle separated by distances subequal to their own diameters.

Male. Length 11.7 mm.; width 3.6 mm. Antenna extending two segments beyond the basal prothoracic angle, more strongly serrate; the segments including the third very strongly triangular, their outer angles produced and more acute than in the female but with their outer margins similarly straight; the antennal pubescence erect. First segment of each anterior tarsus with a comb of short spines on the inner side. Aedeagus much as in *orchesides* but with the tooth of each lateral lobe much less remote from the apex.

Holotype—♀, Arnprior, Ont., July 10, 1934, (W. J. Brown); No. 3902 in the Canadian National Collection, Ottawa.

Allotype—♂, Ottawa, Ont., (W. H. Harrington).

Paratypes—1 ♀, same data as allotype; 1 ♀, Ottawa, Ont., July 20, 1912, (Beaulieu); 2 ♀, Aylmer, Que., July 15 and 27, 1922, (C. B. Hutchings); 1 ♂, Joliette, Que., July 18, 1904, (J. Ouellet); 1 ♀, Montreal, Que., June, (J. Ouellet).

The paratypes measure from 13.7 to 14.7 mm. In some of them, the lateral pronotal margins and portions of the venter are very dark reddish-brown. The impressions at the middle of the pronotum are strongly developed in all specimens; in our examples of *orchesides*, the impressions are evident in half the specimens but well developed in one only. The two species may be compared as follows:

Body and appendages reddish-brown. Male antenna with the third segment widened apically but not strongly triangular; segments four to ten rather strongly serrate; the outer margins of segments seven to ten not straight, each of these segments subparallel at middle and rather suddenly narrowed near base and widened near apex. Female antenna scarcely serrate, the segments beyond the third parallel. Aedeagus with the tooth of each lateral lobe much more remote from the apex *orchesides* Newm.

Body blackish, the appendages dark reddish-brown. Male antenna with segments three to ten very strongly serrate; each segment with its outer margin straight, gradually widened from base to apex. Female antenna rather strongly serrate, each segment beyond the third strongly triangular. Aedeagus with the tooth of each lateral lobe less remote from the apex *canadensis* n. sp.

Polyphylla Harris

Although several authors have reviewed the species of this genus, our knowledge of them remains in a most unsatisfactory state. However, sufficient material is available to show that four distinct forms occur in Canada. These are readily separated from one another, but their relationships to forms of the United States are in some cases obscure.

***Polyphylla variolosa* Hentz.** This species, which was described originally from Massachusetts, occurs at Trenton, Ont., and at Norway Bay and Ft. Coulonge, Que. The head is well supplied with erect hairs, not devoid of them as stated in Fall's key (1928, Proc. Ent. Soc. Wash., XXX, 30).

***Polyphylla hammondi* Lec.** Occurs at Aweme, Man.; specimens from this locality agree in every respect with specimens from the type locality, Riley Co., Kans., and with specimens from Pratt Co., Douglas Co., and Medora, Kans. None of these show any traces of the elytral vittae which are distinct in specimens from New Mexico. This suggests that the vittate forms, such as *subvittata* Lec. and *sejuncta* Csy., should not be considered identical with *hammondi*.

***Polyphylla decemlineata* Say.** This name was based on specimens from

the Platte and Arkansas Rivers. We have six specimens from Sioux Co., Nebr., which are certainly this species and which agree with eleven specimens from Big Sandy, Mont., Cabri, Sask., and the following localities in Alberta: Medicine Hat, Lethbridge, Red Deer, Steveston, Dunes, and Writing-on-Stone. In five of the Canadian specimens, the pronotum is more or less reddish; in the others, it is not paler than the elytra.

Polyphylla perversa Csy. Study of Casey's descriptions and specimens show that this name may be applied to specimens from British Columbia, all of which differ in color from *decemlineata* as noted in the following key. I can detect no other differences, but the material at hand is sufficient to establish the significance of the color character. The type of *perversa* was collected at Friday Harbor, Wash. The species is as large as *decemlineata*, the smallest specimens measuring 26 mm. Of the twenty-eight specimens at hand, only four have the pronotum as dark as the elytra. Fall (l. c.) listed *perversa* and several other of Casey's names as synonyms of *decemlineata* and suggested that Pacific Coast specimens could be given subspecific standing under the name *pacifica* Csy. Such an arrangement is far too simple for the material contained in the Canadian National Collection. *P. perversa* is represented in our collection by specimens from the following localities in British Columbia: Victoria, Saanich, Invermere, Nanaimo, Buccaneer Bay, Duncan, Oliver, Lillooet, Vernon, Summerland, Edgewood, Penticton.

The Canadian species of *Polyphylla* may be separated by the following key.

1. Elytra conspicuously vittate, each elytron with a sutural, three discal, and a short post-humeral vitta composed of densely placed white scales 3
 Elytra not vittate, the vestiture more or less condensed along the suture and on the disk to form pale spots or lines 2
2. Elytra with numerous irregular spots of closely placed hair-like scales. Que., Ont. *variolosa* Hentz.
 Elytral vestiture sparse, forming poorly defined lines but never condensed in blotches. Man. *hammondi* Lec.
3. Scales of the intervals between the elytral vittae very pale yellow, the intervals not strongly olivaceous. Pronotum usually as dark as the elytra. Sask., Alta. *decemlineata* Say
 Scales of the elytral intervals very deep yellow, this giving the intervals a strong olivaceous cast. Pronotum usually red but sometimes as dark as the elytra. B. C. *perversa* Csy.

Ceutorhynchus hearnei n. sp.

Male. Length 1.6 mm. Blackish; the anterior margin of the prothorax rufescent, the legs and the apical declivity of the elytra reddish-yellow. Elytra with a small patch of densely placed white scales on the sutural intervals behind the scutellum; pronotum with a few similar scales on the median line just before the scutellum and with larger scales on the sides; these white, elongate, and not dense; the pronotum and elytra, except as noted above, and the head and legs without scales but clothed with very fine, brownish-yellow hairs, these not at all flattened or scale-like; those of the elytral intervals arranged in one or two irregular rows, their length subequal to half the width of an interval; those of the striae similar but shorter, not evident in certain lights; underside with broadly oval, white scales few of which are in mutual contact.

Head, pronotum, and basal half of beak very densely punctate, not polished. Front flat; antenna with the funicle of seven segments, the club short and stout. Pronotum with the anterior margin truncate at middle, very obtusely subangulate on each side; the subapical constriction only moderately strong; the lateral

tubercles very small but very acute. Elytra convex as in *convexipennis* Fall but less elongate than in that species; the intervals wide, polished, rather feebly roughened; the subapical umbones with fine, acute granules. Fourth segment of anterior tarsus equal in length to the second and third, the portion extending beyond the lobes of the third equal in length to the third segment; tarsal claws and femora not toothed.

Male characters. Last abdominal segment with a strong, transversely oval impression; the impression extending over the full length and over a little more than one-third the width of the segment. Middle and posterior tibiae distinctly unguiculate.

Female. Length 2 mm. Beak more slender but with antennae inserted at middle as in the male. Impression of the last abdominal segment similar but less transverse, extending over about one-third width of the segment. Middle tibiae distinctly unguiculate.

Holotype—♂, Churchill, Man., July 3, 1937, (W. J. Brown); No. 4282 in the Canadian National Collection, Ottawa.

Allotype—♀, same data, July 15, 1937.

This species falls in the *squamatus* group of Dietz and may be recognized by its color and vestiture. The unguiculate middle tibiae of the female is a notable character.

***Centorhynchus munki* n. sp.**

Female. Length 1.9 mm. Entirely black. Head and pronotum clothed with very fine and very indistinct, brownish-yellow hairs; the pronotum with a few white hairs before each lateral tubercle and with a few small, elongate, white scales on the median line in front of the scutellum. Elytra lacking a scutellar spot of scales; each interval with one or two irregular rows of very fine, brownish-yellow hairs, the length of the hairs not quite as great as the width of an interval, the hairs becoming whitish near the sides; striae with each puncture supplied with a hair-like but flattened, white scale; underside with broadly oval white scales, these sparse on the abdomen, closer but not dense anteriorly.

Head, pronotum, and basal half of beak densely punctate, polished. Front not flattened; antenna with the funicle of seven segments, the club moderately stout. Pronotum with the anterior margin not truncate, not angulate; the subapical constriction quite strong; the lateral tubercles scarcely elevated but very acute. Elytra moderately convex and elongate; the intervals wide, polished, rather feebly roughened; the subapical umbones with fine, acute granules. Fourth segment of anterior tarsus equal in length to the second and third, the portion extending beyond the lobes of the third equal in length to third segment; tarsal claws and femora not toothed.

Female characters. Antennae inserted at middle of beak. Last abdominal segment not impressed. Tibiae not unguiculate.

Holotype—♀, Churchill, Man., July 16, 1937, (W. J. Brown); No. 4283 in the Canadian National Collection, Ottawa.

Paratypes—2 ♀, same data; 1 ♀, same data, July 29, 1937.

This species, also, belongs to the *squamatus* group. It may be recognized by the characters of its vestiture. In *convexipennis*, the species with which *munki* is most likely to be confused, the vestiture of the head and thorax is white and quite distinct, and the vestiture of the elytral intervals scarcely differs from that of the striae. The paratypes of *munki* are similar to the holotype in size.

RESEARCH NOTE

ON THE OCCURRENCE OF *PAPILIO POLYDAMAS* LINNAEUS WITHIN THE UNITED STATES

In their excellent "Revision of American Papilios" (1906, *Novitates Zoologicae*, XIII, p. 521). Rothschild and Jordan described *Papilio polydamas lucayus* subsp. nov. from the Bahamas, and in "Notes on some Tropical Florida Butterflies" (1934, *Ent. News*, XLV, p. 166), Marston Bates very correctly pointed out that this name should be applied to Florida specimens of *polydamas*. The following year Comstock and Grimshawe published the "Early Stages of *Papilio polydamas lucayus* R. and J." (1935, *Bulletin Southern California Academy of Sciences*, XXXIV, pp. 76-80) based upon Florida specimens.

However, the fact seems to have been overlooked in the "Check List of the Lepidoptera of Canada and the United States of America" by Dr. J. McDunnough (1938, *Memoirs Southern California Academy of Sciences*, I, p. 5.) that *Papilio polydamas polydamas* L. (1758, *Syst. Nat.*, Ed. X, p. 460, n. 11) also occurs within the United States. Rothschild and Jordan (loc. cit., p. 521) distinctly state that its distribution is from Georgia southward to Buenos Aires. When I acquired the Thomas E. Bean collection of Lepidoptera some years ago it contained a pair of *polydamas*, one of which bore a label inscribed "Polydamas ♂ ♀, 'S. W. Texan and Mexican border,' (From Strecker, Sept. 1890)", and with the R. F. Sternitzky collection another pair was received from "Brownsville, Texas, July 13, 1925." These four specimens are typical *polydamas polydamas* and differ from *lucayus* in the characters pointed out by Rothschild and Jordan and Barber. There are also a number of specimens of *polydamas polydamas* from Mexico in the collection of the American Museum of Natural History. Holland (1931, "Butterfly Book," revised edition, p. 312) gives Texas among the localities for this insect. It is, therefore, quite apparent that *polydamas polydamas* should be restored to North American lists and that it should not have been preceded by an asterisk (*) in the 1938 List indicating that it is of doubtful North American occurrence.

Cyril F. dos Passos, Mendham, New Jersey.

BOOK NOTICE

THE CHEMISTRY AND TOXICOLOGY OF INSECTICIDES. By Harold H. Shepard. Burgess Publishing Co., Minneapolis, Minn. Pages i-iii and 1-38. 40 figures. 1939.

For the past few years there has been a growing need for a book of reference on the field insecticides, for although most works on applied entomology contain a section on insecticides, the information given is sometimes very meagre and is widely scattered. Also much of the useful information on the subject is contained in sources not often consulted by the entomologist. This need is largely met by the present volume, which is designed as a reference book on the subject, with prime consideration given to the historical, physical, chemical and toxicological aspects, to the action of the insecticides rather than their application to insect control. As a reference the volume is relatively inexpensive, being mimeographed on both sides of good quality 'impression' paper.

The volume contains a foreword, a table of contents, eleven chapters, an appendix and an index. The adequacy and scope of the text matter is indicated by the chapter headings which are as follows: 1. Introduction, 2. History of Insecticides, 3. Principles of Insecticide Toxicology, 4. Quantitative Toxicology of Insecticides, 5. Stomach Poisons: Arsenicals, 6. Stomach Poisons: Non-Arsenical Inorganic Compounds, 7. Contact Insecticides I: Sulfur and Copper Compounds, 8. Contact Insecticides II: Adjuvants; Oil and their Derivatives, 9. Plant Derivatives and Related Compounds, 10. Insect Fumigants, 11. Miscellaneous Chemical Control, Appendix, Conversion Tables, Tables of Measures and Weights.

R. H. Ozburn.

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